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## Some Araucarian remains from the Atlantic coastal plain \*

EDWARD W. BERRY

(WITH PLATES II-16)

The considerable theoretic importance recently assigned to the Araucarieae by some authors, coupled with their abundance and wide range during the Mesozoic and their restriction in modern floras to the South American and Australian areas, renders them a most interesting group of plants, as they are undoubtedly among the most curious and striking in appearance.

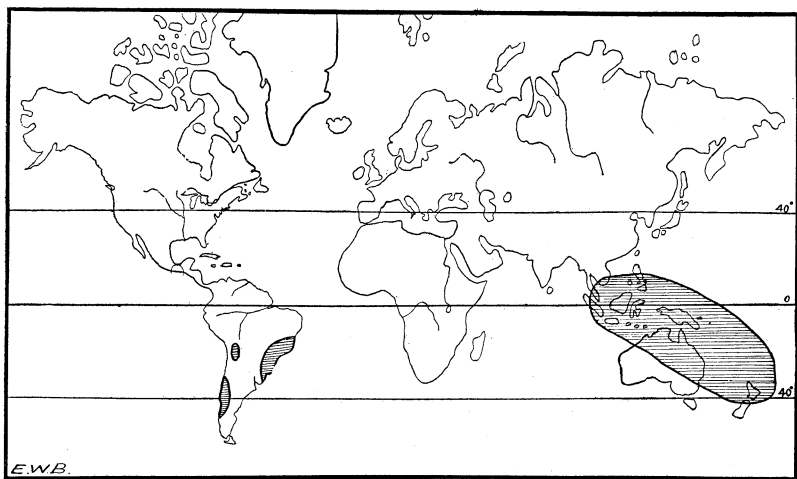


FIGURE 1. Sketch map, showing the distribution of the Araucarieae in the modern flora.

The geographical distribution of the recent species is included within the lined areas of FIGURE 1. The wide extension of the oriental area is due chiefly to the genus *Agathis*, which is essentially an island type, ranging from the Philippines to New Zealand. It is to be noted that this genus does not occur in the Western Hemisphere, although during the Cretaceous rather closely allied ancestral forms (*Dammara*, *Protodammara*, and *Dammarites*)

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ranged from Greenland to New Jersey and Montana. Unfortunately, the more familiar generic term for those plants, *Dammara*, is a pre-Linnean name, having been proposed by Rumphius in 1741,\* so that recently systematists have taken up the name *Agathis* proposed by Salisbury in 1807.†

The genus *Araucaria* is chiefly oriental, with eight or nine species, all but one belonging to Endlicher's subgenus *Eutacta*, (1847), characterized by more or less acicular, keeled leaves and winged cone-scales. This subgenus is not represented in South America, the two or three species from that continent being referable to the subgenus *Columbea* (Salisbury, 1807), characterized by broad flat leaves, and with one species, *Araucaria Bidwilli*, in the Australian region (the "Bunya-Bunya" of southern Queensland). It will be noted also that North America, Europe, Africa, and practically all of Asia contain no representatives of this subfamily.

It is not my purpose to sketch the past history of this group, a task recently performed by Seward & Ford, who point out the probable Araucarian affinity of the Paleozoic genera *Walchia*, *Schizodendron* (*Tylodendron*), *Gomphostrobus*, and the possible Araucarian relation of the Triassic genera *Albertia*, *Voltzia*, *Ulmannia*, etc. It is, however, desirable to indicate briefly the probable range of the Araucarieae during the period when the species about to be described flourished, *i. e.*, the Cretaceous.

The recorded occurrences of Araucarieae during the Cretaceous are shown in FIGURE 2. No attempt has been made to revise these data, which may in some instances be based upon insufficient evidence, nor have obviously allied genera like *Brachyphyllum* been included, or any of the many species described as *Sequoias*, some at least of which would seem to be more properly referable to the Araucarieae.

By referring to the map (FIGURE 2), it will be seen that in the Western Hemisphere we have *Agathis* from 70° north latitude (Greenland), and *Araucaria* from 40° south latitude (Patagonia), with several species of both genera in the United States, ranging from Block Island to South Carolina on the east coast and from Montana to Kansas in the western interior. In the Eastern Hemi-

\* RUMPHIUS, G. E. *Herbarium Amboinense* 174. Amsterdam, 1741.

† SALISBURY, R. A. *Trans. Linn. Soc. Lond.* 8: 312. 1807.

sphere we have records as far apart as Spitzbergen ( $80^{\circ}$  North), on the one hand, and Cape Colony ( $30^{\circ}$  South) on the other, with several species of both the *Araucaria* and the *Agathis* type in Europe.

The absence of Asiatic Cretaceous records is to be considered due to the lack of knowledge of Cretaceous plant beds on that continent, and not as indicative of the absence of the Araucarieae at that time.

While the distribution of the recent forms might seem to be an argument for the former existence of Antarctic land connections

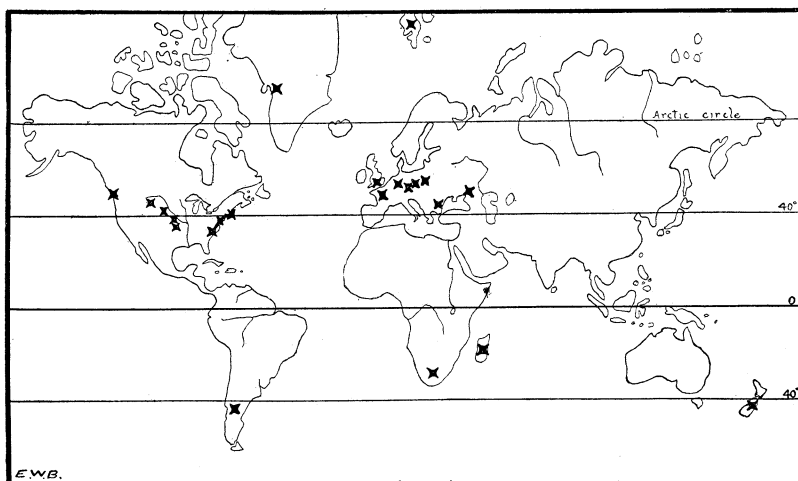


FIGURE 2. Sketch map, showing the recorded occurrences of the Araucarieae during the Cretaceous.

and intermigrations, a glance at the fossil record shows that this is not the true explanation of their present occurrence, nor does it, on the other hand, in the least weaken the probability that there was such an Antarctic continent or archipelago, a view with which the writer is in thorough sympathy. In the case of the Araucarieae, however, the records show that a once cosmopolitan group has gradually become extinct in the intervening areas until its present restricted habitats are all that remain of a once world-wide dominance, a dominance which was probably reached during the later Mesozoic.

As a corollary, we would assume that the group is still

dwindling, and this is borne out not only by its much wider range in the Tertiary but by the presence of sub-fossil remains of *Agathis* in New Zealand, and of *Araucaria* in South America, in both cases showing a marked shrinkage in range in very recent times.

During the past two or three years the writer has come into possession of a considerable quantity of Araucarian remains from the Atlantic coastal plain. These are all of Mid-Cretaceous age and it seems desirable to place them on record at the present time since unquestionable remains of the genus *Araucaria* have not been previously recorded from this general region and the final treatment of these South Atlantic Cretaceous floras will undoubtedly take a long time.

The New Jersey material comes from beds of the Magothy formation, very probably of Cenomanian age. The Carolina forms are from beds which differ in age but slightly if at all from those of New Jersey, although they may be somewhat older, possibly synchronous with the Raritan formation of New Jersey and the Tuscaloosa formation of Alabama, the question of exact correlation being under active investigation at the present time.

Evidences of the abundance of the Araucarieae, using that term in a somewhat extended sense, have been emphasized recently through the studies of Hollick & Jeffrey\* upon Staten Island material; and Seward & Ford† in their most admirable sketch of the recent and past history of this group have furnished good ground for the belief that the Araucarieae are the most abundant type of Coniferales in the Older Mesozoic.

Following is a brief discussion of the hitherto unknown Atlantic coastal plain species :

***Araucarites Zeilleri* sp. nov.**

Cone a prolate spheroid, about  $9 \times 7$  cm.; scales numerous, long, narrow, thick; cone-axis stout; details of structure obscured. (PLATE II, FIGURE 3.)

At the first glance this looks like a very beautifully preserved Araucarian cone, but closer inspection shows that poorness of preservation has obscured nearly all of the details of structure,

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\* HOLLICK & JEFFREY, *American Naturalist* 40: 189-216. 1906.

JEFFREY, *Bot. Gaz.* 44: 435-444. *pl.* 28-30. 1907.

† SEWARD & FORD, *Philos. Trans. Roy. Soc. Lond.* 198 B: 305-411. 1906.

megascopic as well as microscopic. The specimen consists of about one half of a flattened cone, diagonally fractured in a plane not greatly inclined to the longitudinal axis, the latter being hidden distally by the cone-scales and weathered away proximally.

This cone was evidently lignified in the clays and subsequently penetrated peripherally by pyrite for a distance of about 1.5 cm., which, while serving to hold together the much cracked and dessicated interior, also effectually obscures the surface features. It was found among the shingle at low tide on the beach at Cliffwood Bluff, N. J., having been washed out of a body of clay which makes the floor of the beach at this point, and was broken when found, no trace of the other half having been seen.

The specimen is 9.3 cm. long, 7.8 cm. wide at right angles to the flattening force, and 2.5 cm. thick, so that in life the cone must have been almost spherical—a slightly prolate spheroid. The scales were numerous, comparatively long and slender, and the cone-axis was very stout.

In this connection a number of fossils of a more or less doubtful nature from this locality suggest themselves as of Araucarian affinities, notable among which are the leafy twigs referred to Presl's genus *Cunninghamites*, so named for their resemblance to the existing genus *Cunninghamia*, and usually referred to the Taxodiaceae, although in Zittel's Handbuch (abth. 2, 1890) they are placed by Schenk in the Araucarieae. Two species have been recorded from this locality, *Cunninghamites elegans* (Corda) Endl. and *C. squamosus* Heer, both suggesting Araucarian foliage of the type found in the *Eutacta* section of the genus *Araucaria*. The broad-leaved type of foliage of the subgenus *Columbea* is probably also present at Cliffwood Bluff in the species *Araucarites ovatus* Hollick, to which I will refer on a subsequent page.

Other doubtful remains from this locality which are suggested as possibly of Araucarian affinities are the fossils denominated *Microzamia* (?) *dubia* Berry\* and supposed to represent the central axis of a cycadaceous fruit-spike. This might well represent the axis of an Araucarian cone like the one under discussion, more especially as the scales are shed at maturity (in the recent species at least); the small prominence in the spirally disposed pits of the

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\* BERRY, Bull. Torrey Club 32: 43. pl. 1. f. 2. 1905.

specimen would then represent the single vascular bundle which passed into the base of the scale. This object is now refigured (PLATE II, FIGURE 1).

Another problematical fossil which may possibly belong to the Araucarieae is the cone previously described simply as "gymnospermous cone" Berry\* and refigured on PLATE II (FIGURE 2). This might be a staminate Araucarian strobilus, for while most of the modern Araucarieae have greatly elongated staminate strobili, they become shortened and subcylindrical in some species, as for example in *Araucaria excelsa*, the Norfolk Island pine and more particularly in the genus *Agathis* (*Dammara*).

*Araucarites Zeilleri* may be compared with the cone described by Velenovsky from the homotaxial deposits (Cenomanian) of Bohemia under the name of *Araucaria bohémica*,† which is seen to be similar in appearance, and to the several species of cones of *Araucaria* and *Pseudo-araucaria* which have been described by Fliche from the Albien of France (Bull. Soc. Sci. Nancy, 171-195. pl. 5. f. 4, 5; pl. 6. f. 2-5; pl. 7. f. 1, 2. 1896).

Nothing similar has heretofore been collected at Cliffwood Bluff, where so many coniferous remains have been found, and it is of especial interest in coming after the recent announcement by Hollick & Jeffrey (*loc. cit.*) of two types of *Araucarioxylon* lignite from the not distant and possibly homotaxial horizon at Kreischerville, Staten Island,‡ one type which they have correlated with *Brachyphyllum* twig-impressions and with *Protodammara* cone-scales and the other more like recent Araucarian wood — which might well represent the present species — with resinous tracheids, no traumatic resin canals, and with a large pith composed mainly of tanniniferous cells. It has seemed best to use the generic term *Araucarites* as one which is of broader significance than *Araucaria*, since the preservation of the cone is such that it might equally well be considered as a Mid-Cretaceous representative of the allied genus *Agathis* (*Dammara*).

\* BERRY, *loc. cit.* 31: 72. pl. 4. f. 7. 1904.

† VELENOVSKY, Květena českého cenomanu, 8. pl. 1. f. 20-24. 1889.

‡ The major part of the Kreischerville deposit is of Raritan age but there is some evidence that the leaf-bearing layers may be later.

***Araucaria bladenensis* sp. nov.**

Foliage dense ; phyllotaxy spiral ; leaves decurrent, coriaceous, ovate-lanceolate, about  $1.6 \times .8$  cm., the base rounded, apex thickened, cuspidate ; veins immersed, averaging 16 in number, straight, parallel ; stomata small, in rows on ventral surface. (PLATES 12 AND 13 ; PLATE 14, FIGURES 1-3.)

Leaves ranging from 1 to 2.8 cm. in length by .5-1.2 cm. in width, averaging 1.6 by .8 cm., obovate in outline, with a broad rounded base narrowing abruptly and decurrent ; the blade broadest about one third of the distance from the base, above which point it narrows rapidly to a thickened cuspidate tip ; phyllotaxy spiral ; leaf-substance represented by a thick sheet of lignite about .5 mm. thick, in which the veins are immersed. These veins average 14 to 16 in number, although occasionally there may be as many as 20 ; they are stout, incurved at the base (forking not observed), becoming parallel and running directly upward until they abut against the leaf margin, *i. e.*, not convergent toward the tip of the leaf. When this species was first collected it was thought that it might be sufficiently well preserved to show the internal structure when studied by the admirable methods devised by Professor Jeffrey for treating more or less refractory remains of this sort. Professor Jeffrey, who has been good enough to examine some of these leaves for me with this end in view, writes that in spite of their hopeful megascopic appearance their microscopic structure is not preserved.

In one or two instances where the specimens are in a more argillaceous matrix it has been possible to get rather inferior specimens showing the arrangement and outlines of the stomata (PLATE 14, FIGURE 3). These are broadly ovate in shape with very thin guard cells (at least when viewed on the surface). They are arranged in somewhat irregular rows on the ventral surface of the leaf, the number of rows between the two veins being usually four. Aside from the foregoing facts, the preservation is such that no other details can be made out.

This species is most remarkably similar to the recent *Araucaria Bidwilli* of the Australian region, a twig of which, kindly furnished by the New York Botanical Garden, has been photographed and introduced on PLATE 15 for comparison. The resemblance is even closer than the reproductions indicate, a dried herbarium specimen



of the latter and a twig of the former preserved as a brownish impression in the Rockfish Creek clays being practically indistinguishable. This resemblance in form, habit, and stomatal characters, reinforced by the occurrence of characteristic Araucarian cone-scales in the same beds at certain localities, renders the identification reasonably conclusive.

A wide comparison has been made with other and similar fossil remains of Mesozoic age. The most nearly related form seems to be *Araucarites ovatus* (PLATE 14, FIGURES 4, 5) described by Hollick \* from the Cliffwood clays of New Jersey, which differ merely by their larger size, absence of basal characters, and much less pointed tips; in fact, if the two were found in closer association or if in the abundant Carolina material any specimens had approached *Araucarites ovatus* in size I would be disposed to consider them as the variants of a single species. As the case stands, it seems better to institute a new species, since the leaves in the Carolina material are sufficiently and uniformly different enough to be readily recognized, and there is the further possibility that the New Jersey species may be more or less closely related to the modern genus *Agathis* (*Dammara*) rather than to *Araucaria*.

A genus which was at once suggested for comparison was the genus *Nageiopsis* of Fontaine, the real botanical position of which is so uncertain. It is true that Fontaine characterizes the leaf-arrangement as distichous or subdistichous, but this is the ordinary habit of numerous conifers with a spiral phyllotaxy and one which would be emphasized in fossil remains preserved as impressions. There is some resemblance to *Nageiopsis ovata* Font.† from the Older Potomac of Virginia. However, an examination of the type material in the U. S. National Museum demonstrates the distinctness of the Carolina species, as it does also the exceedingly inaccurate figures of Fontaine's monograph. Another of this author's species which is somewhat similar is *Nageiopsis montanensis*, described from the Kootanie of Montana, ‡ but since it is founded on a single specimen and there are no features which indicate that

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\* HOLLICK, Trans. N. Y. Acad. Sci. 16: 128. pl. 12. f. 3a, 4. 1897.

† FONTAINE, U. S. Geol. Surv. Monog. 15: 199. pl. 77. f. 4; pl. 80. f. 5. 1889.

‡ FONTAINE, loc. cit. 48: 312. pl. 73. f. 10. 1906.

it really is a *Nageiopsis*, it is not worth considering further in this connection.

A European form which must surely be considered as a nearly related congener of *Araucaria bladenensis* is Saporta's *Araucaria Toucasi* described from the Turonian of Beausset near Toulon, France.\* This is strikingly similar to the Carolina species in every respect and likewise closely allied, in appearance at least, to the recent *Araucaria Bidwilli* of Australia.

Kerner† records *Pachyphyllum* (*Pagiophyllum*) *rigidum* Saporta and *Pachyphyllum* (*Pagiophyllum*) *araucarinum* Saporta from the Cenomanian of Lesina, an island in the Adriatic off the coast of Dalmatia, both being originally Jurassic species from the French Corallien of Verdun‡. Both are very similar to the Carolina species and are of about the same age. The probable identity of Cenomanian and Corallian species, it seems to me, is extremely doubtful, and both of Kerner's species should undoubtedly be considered as new species of *Araucaria* and nearly related, if not identical, with such Mesozoic forms as *Araucaria bladenensis* or *Araucaria Toucasi*.

Other fossil remains which deserve to be mentioned in this connection and which may really be Araucarian, although abundantly distinct from this Carolina species, are *Podozamites* ? *acutus* Saporta § from the Neocomian of Portugal, whose resemblance to *Nageiopsis ovata* and *N. zamioides* is noted by Saporta; and *Podozamites lanceolatus* (L. & H.) F. Braun forma *elliptica* Möller from Bornholm || which is scarcely to be distinguished from *Nageiopsis montanensis* Font. from the Kootanie; and *Pagiophyllum* sp. Dawson ¶ from the Kootanie of Canada.

*Araucaria bladenensis* occurs abundantly as detached leaves in the Cretaceous dark-drab, very lignitic clays, at numerous localities in the south Atlantic Coastal plain, and occasionally as twigs of considerable size showing phyllotaxy and other characters. It is preëminently the type fossil of the Bladen formation of North Caro-

\* SAPORTA, Le Monde des Plantes 198. f. 27. 1879.

† KERNER, Jahrb. k.k. Geol. Reichsanst. 45: 49. pl. 4. f. 3; 50. pl. 4. f. 1

‡ SAPORTA, Plantes Jurassiques, Paléont. Franc., Végétaux, pl. 177, 178.

§ SAPORTA, Fl. Foss. Portugal 87. pl. 16. f. 28. 1894.

|| MÖLLER, Kongl. Sv. Vet.-Akad. Handl. 36<sup>o</sup>: 8. pl. 7. f. 9. 1903.

¶ DAWSON, Trans. Roy. Soc. Can. 10<sup>4</sup>: 90. f. 14. 1892.

lina,\* single leaves or even fragments being quite characteristic and easy of recognition. Discovered originally in material collected at Parker Landing by Dr. L. W. Stephenson in 1906, it has since been found in a large number of outcrops of this formation in this same general region.

Following are the localities from which it is known at the present time:

NORTH CAROLINA: Parker Landing, Tar River (abundant); 95  $\frac{1}{2}$ , 92, 87  $\frac{5}{8}$ , and 87  $\frac{1}{2}$  miles above Newbern, Neuse River; Big Bend (abundant), Sykes Landing, Clear Run, Corbits (Old Union) bridge, A. C. L. R. R. bridge, Horrel Landing, and 74  $\frac{3}{4}$  miles above Wilmington, Black River; Rockfish Creek, near Hope Mills (abundant); mouth of Harrison's Creek, Cape Fear River.

SOUTH CAROLINA: 3 to 4 miles northeast of Florence.

ALABAMA: 2 miles south of Havana in Hale County.

### *Araucaria Jeffreyi* sp. nov.

Cone-scales deciduous, rhomboidal, straight-sided, thin-margined, the apex broadly rounded, with long central apical spur; scales divided by transverse furrow into "ligule" and scale proper, single-seeded. (PLATE 16.)

This species is represented by a considerable number of large single-seeded cone-scales preserved as impressions and associated with *Araucaria bladenensis* at Big Bend and A. C. L. R. R. bridge on the Black River, at 92 and 87  $\frac{5}{8}$  miles above Newbern on the Neuse River and at Parker Landing on the Tar River, all localities in North Carolina. The latter specimens differ somewhat from the others and approximate more nearly the shape of the foliage leaves of *Araucaria bladenensis*, but since the scales from the former locality are somewhat variable, as indeed they are from different positions on a single modern Araucarian cone, it seems likely that they all belong to one species of cone.

The scales are rhomboidal, the thin lateral margins straight to the point of greatest width, then more or less rounded, produced medianly into a long and narrow point. This point is over a centimeter long in two specimens which still lack the terminal portion. In some specimens the scales are obviously divided by a

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\* STEPHENSON, Johns Hopkins Univ. Circulars, II. 1907<sup>†</sup>: 95. 1907.

transverse furrow into the scale proper and the so-called "ligule." This feature is not shown in FIGURES 10 and 11, which probably represent the transitional phase between functional scales and foliage leaves toward the base of the cone, while the additional variations in the specimens figured are probably likewise correlated with the regions of the cone from which they came. They are all preserved as impressions with fragments of lignite representing the scale-substance. With the exception that they do not appear to have been as thick, they are strictly comparable with the typical scales of *Araucaria Bidwilli*. In general outline they are also comparable with the scales of *Araucaria Cookii* of the *Eutacta* section of the genus. Although no seeds have been found as yet in the Carolina material, it seems likely that they will eventually be discovered. From the structure as disclosed in the present impressions it seems obvious that the scales were single-seeded as in the modern genus, and, taken in conjunction with the foliage just described as *Araucaria bladenensis*, they furnish conclusive evidence of the abundant presence in the Mid-Cretaceous of eastern North America of true Araucarieae, thus still further increasing the parallel between the Mid-Cretaceous floras of this country and those of Europe.

Many remains of cones and cone-scales have been described as species of Araucarieae but it seems scarcely worth while to enumerate them in this place. Some have already been mentioned under *Araucarites Zeilleri*, and for others the reader is referred to the monograph of Seward & Ford (*loc. cit.*).

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**Explanation of plates 11-16**

## PLATE 11

FIG. 1. *Microzamia* (?) *dubia* Berry. A possible Araucarian cone-axis, Cliffwood, N. J.

FIG. 2. Gymnospermous cone, Berry. A possible Araucarian staminate cone, Cliffwood, N. J.

FIG. 3. *Araucarites Zeilleri* Berry, sp. nov. Cliffwood Bluff, N. J.

## PLATE 12

*Araucaria bladenensis* Berry, sp. nov.

FIGS. 1-3. Rockfish Creek, N. C.

FIG. 4. Horrel Landing, N. C.

## PLATE 13

*Araucaria bladenensis* Berry, sp. nov. Showing form of detached leaves and their usual method of occurrence. Parker Landing, N. C.

## PLATE 14

FIGS. 1, 2. *Araucaria bladenensis* Berry, sp. nov. Showing closely imbricated leaves at the fork of a branch. Parker Landing, N. C.

FIG. 3. *Araucaria bladenensis* Berry, sp. nov. Showing form and arrangement of the stomata, enlarged about 20 times. Rockfish Creek, N. C.

FIGS. 4, 5. *Araucarites ovatus* Hollick. Introduced for comparison. (After Hollick.) Cliffwood Bluff, N. J.

## PLATE 15

*Araucaria Bidwilli* Hook. From a photograph (natural size) of an herbarium specimen. Introduced for comparison. Photograph by E. H. Sapp.

## PLATE 16

*Araucaria Jeffreyi* Berry, sp. nov.

FIGS. 1-9, 12. Big Bend, N. C.

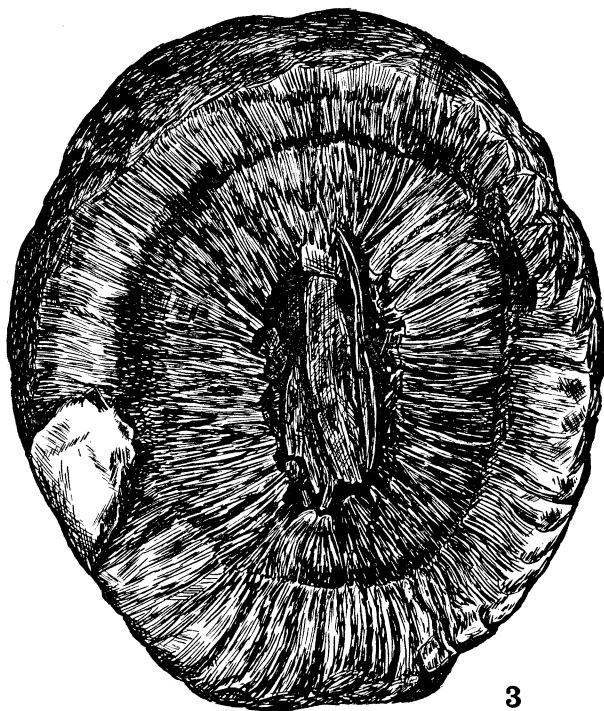
FIGS. 10 11. Parker Landing, N. C.



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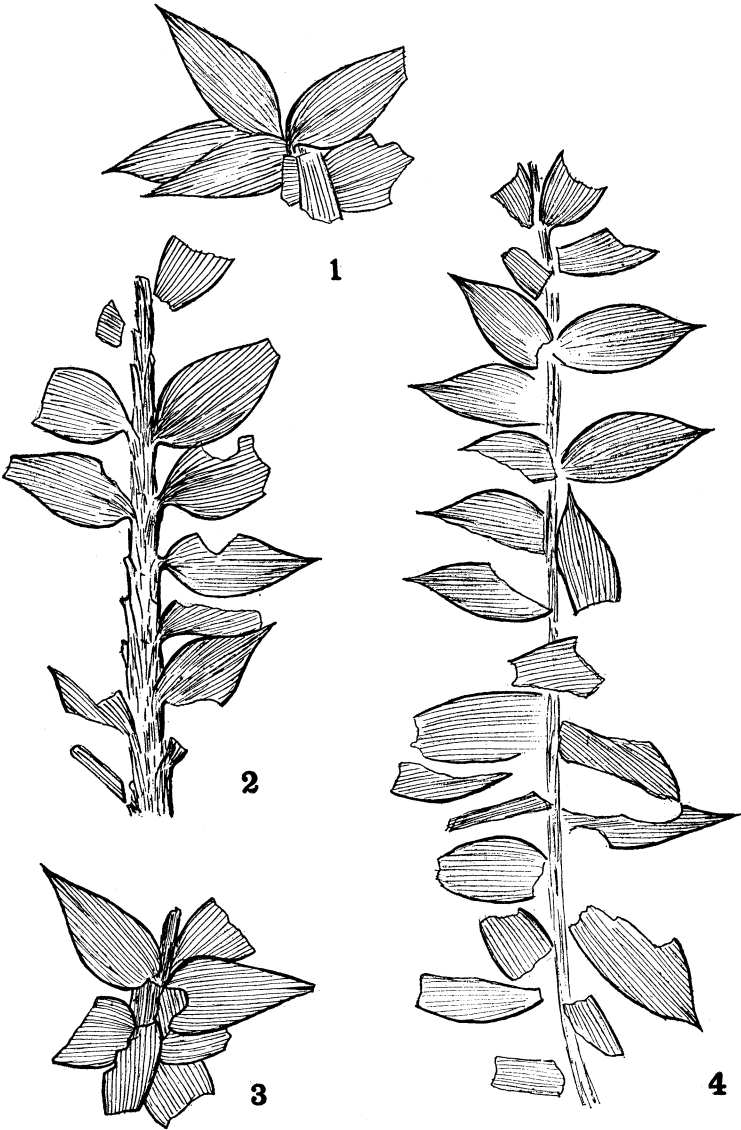


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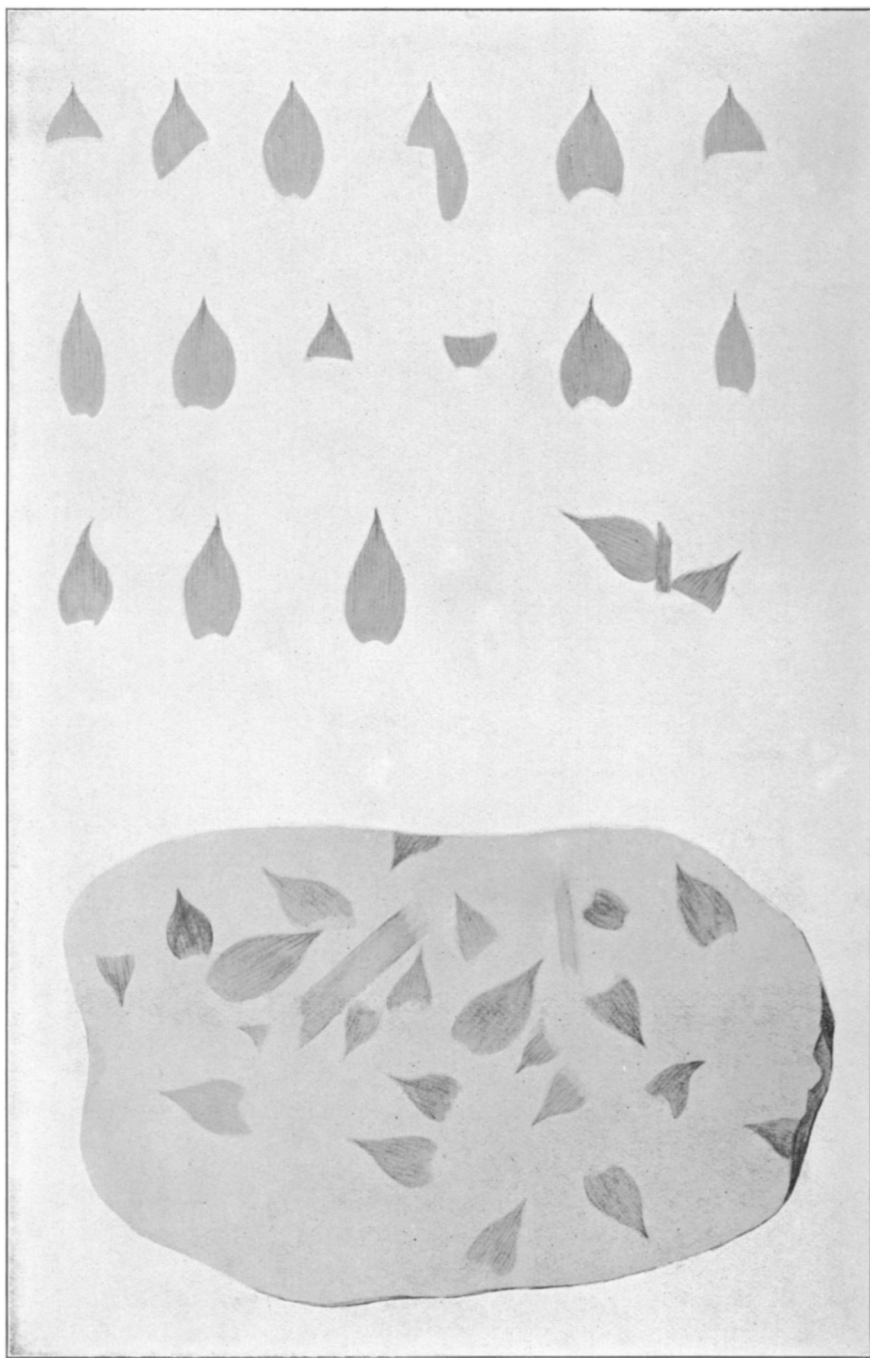


3

1. MICROZAMIA (?) DUBIA Berry
2. GYMNOSPERMOUS CONE
3. ARAUCARITES ZEILLERI Berry

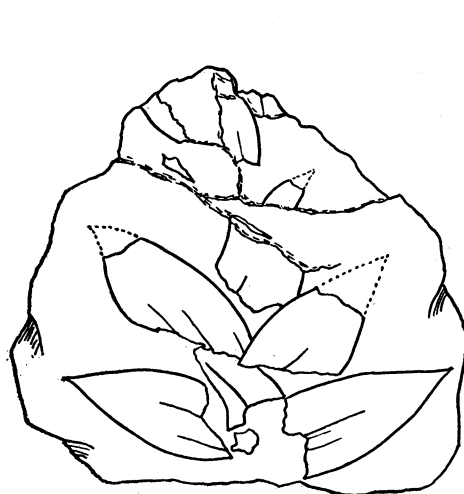
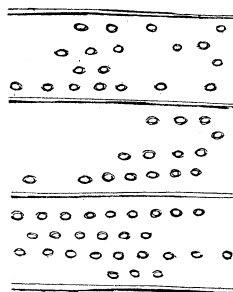
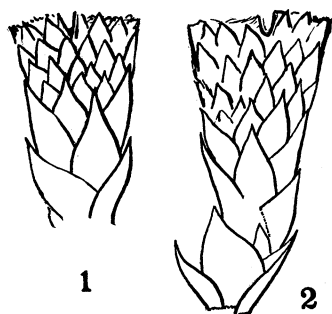


ARAUCARIA BLADENENSIS Berry

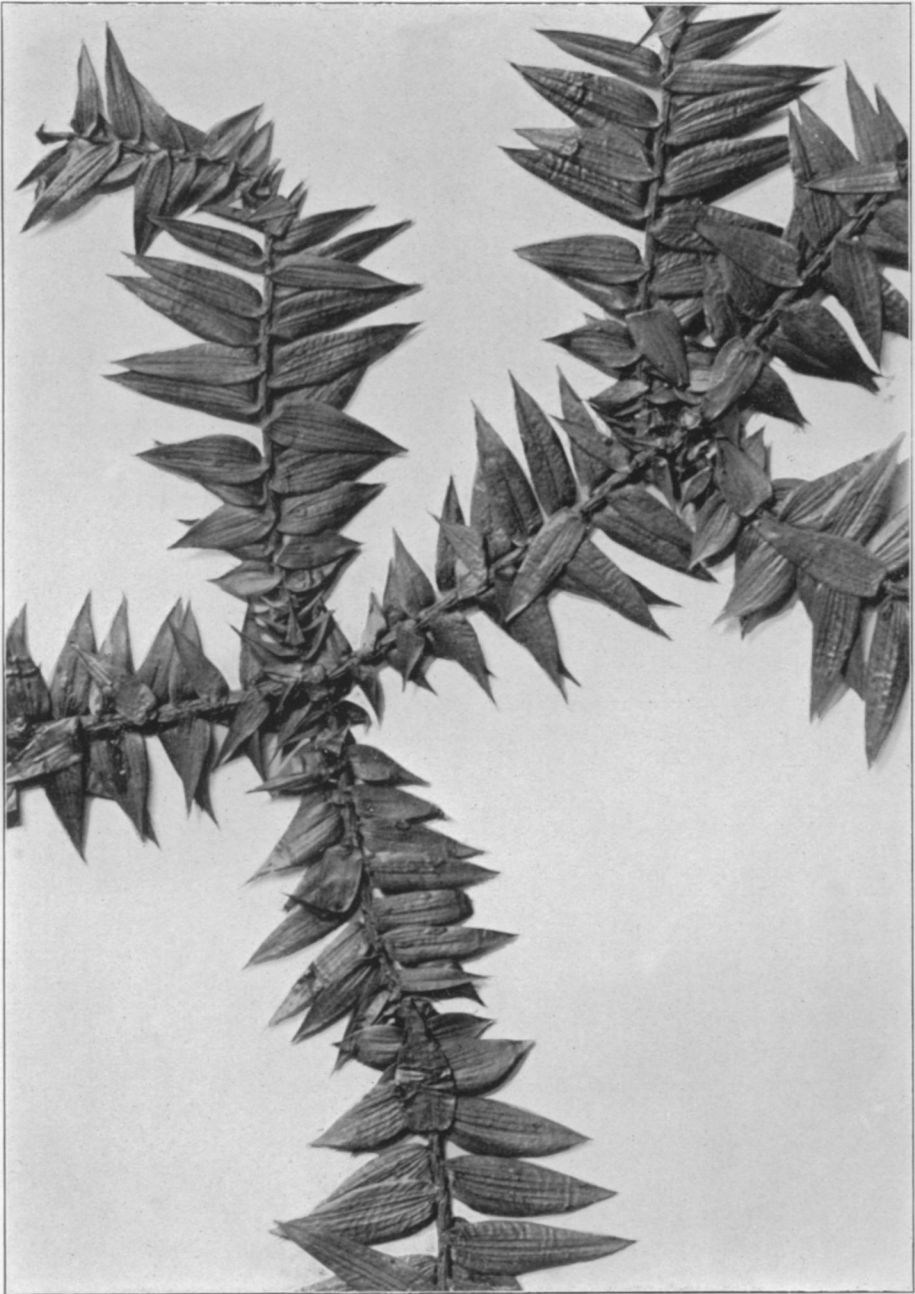


ARAUCARIA BLADENENSIS Berry

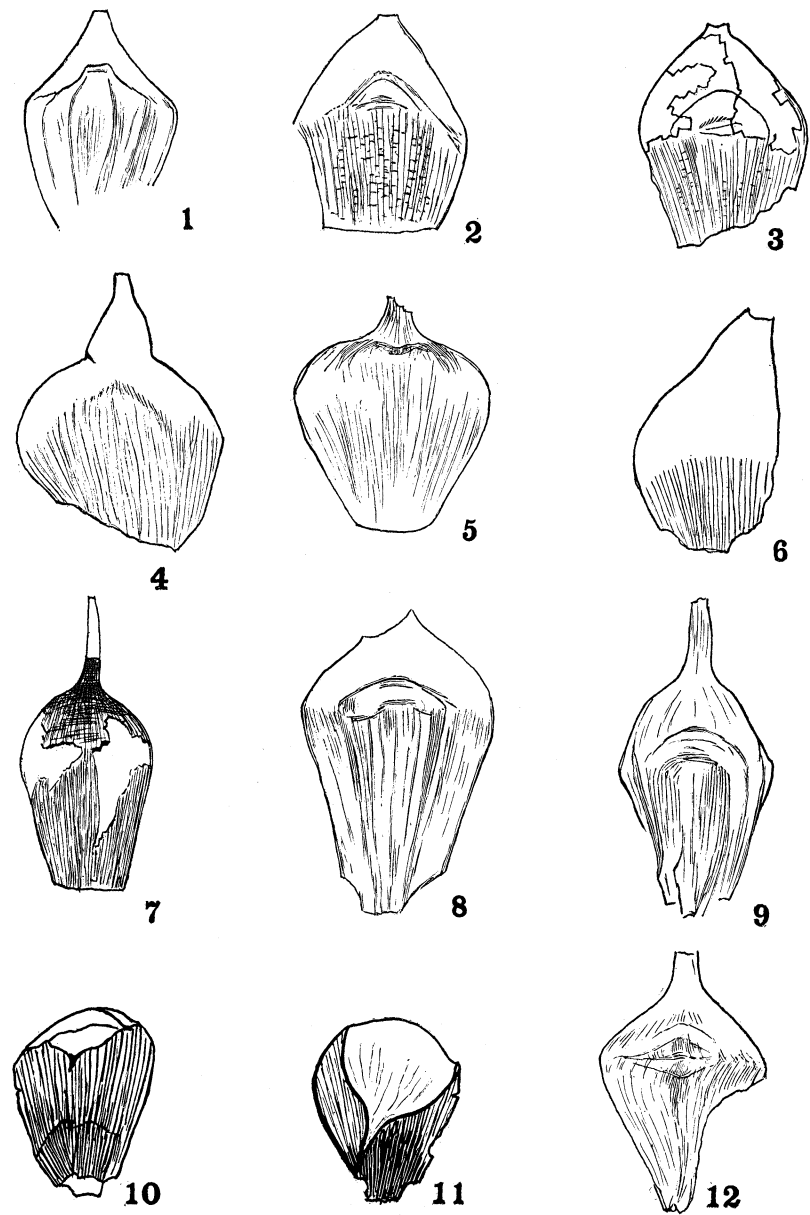




1-3. *ARAUCARIA BLADENENSIS* Berry  
4 and 5. *ARAUCARITES OVATUS* Hollick



ARAUCARIA BIDWILLI Hook.



ARAUCARIA JEFFREYI Berry